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MANUFACTURE AND CONSTRUCTION OF STRINGS

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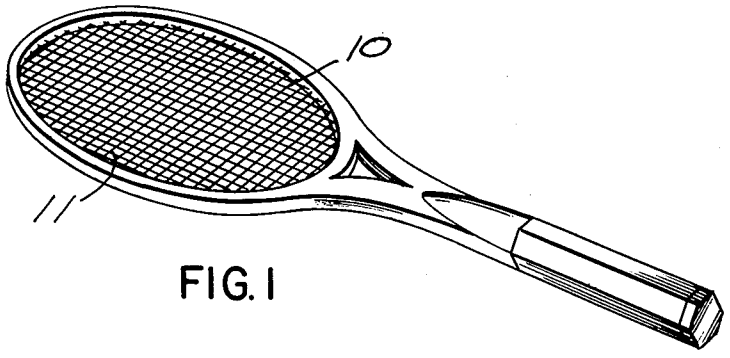

FIG. 1

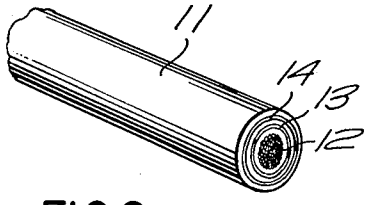

FIG. 2

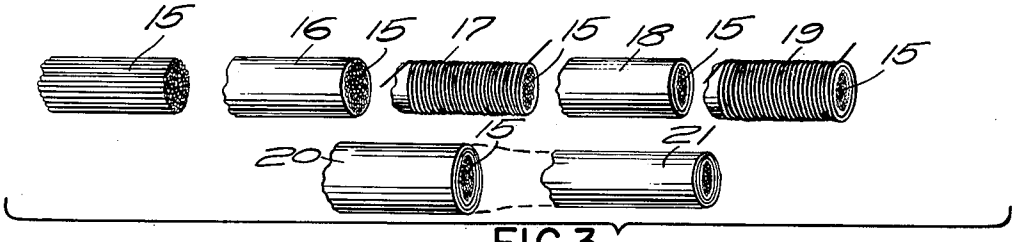

FIG. 3

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MANUFACTURE AND CONSTRUCTION OF STRINGS

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5 Claims. (Cl. 57—140)

The present invention relates to the manufacture of strings for stringing tennis, badminton and squash racquets and for musical instruments, and has particular reference to a novel manufacture and a novel construction therefor.

The principal object of the invention is to provide an improved string for tennis racquets, musical instruments, and the like.

Another object of the invention is to provide an improved string comprising a filament core and an integrally joined sheath.

A further object of the invention is to provide an improved string having great strength, elasticity, and resistance to fatigue and distortion.

With the above and other objects and advantageous features in view, the invention consists of a novel method and a novel article more fully discolsed in the detailed description following, in conjunction with the accompanying drawings, and more specifically defined in the claims appended thereto.

In the drawings,

Fig. 1 is a perspective view of a tennis racquet strung with the improved string;

Fig. 2 is an enlarged portion of the string, parts being broken away to show the elements thereof; and

Fig. 3 is a perspective enlarged view showing the appearance of the string during the different stages of manufacture.

It has been found desirable to provide an improved string for tennis racquets, and the like, which has great strength, is very resilient, has great resistance to tension strains and to flexing, and has a smooth water repellent outer surface. To this end, I have devised a composite construction which utilizes a center flexible core of high resiliency, preferably made of linear synthetic plastic filaments, and a tough composite armor sheath, preferably including a textile winding and a synthetic plastic filament winding, the sheath being integrally locked to the core to provide a smooth, hard, abrasion resisting string and having an outer smooth coating.

I have found that a suitable plastic for such strings is the amido-polymer, vinylite and polyester types, and that nylon is particularly desirable because it orients under tension when drawn down to the desired diameter to increase the strength of the string.

Referring to the drawings, Fig. 1 illustrates a racquet **10** which has been strung with the improved string **11**. The string **11**, as shown in Fig. 2, has a linear filament core **12** which is flexible and of high resiliency and an armor sheath **13**, which is tough and wiry, the core and the sheath being integrally locked, preferably with synthetic plastic **14**. The resulting string has an integrated linear core and a wound sheath with a smooth outer coating, is hard and tough, and does not abrade when pulled through the string holes of the racquet.

The improved string is manufactured by first forming a core of linear strands as indicated by the reference numeral **15** in Fig. 3. This core is passed through a

tank containing a solution of a special coating material, which preferably has a nylon base, it being preferred to apply several thin layers of a coating rather than a single heavier layer. The coated core may be lightly brushed to obtain a smooth finish, as indicated by the reference numeral **16**, and then air dried, and textile thread is wound spirally over the coated core as indicated by the reference numeral **17**. The covered core is again coated by passing through the integrating solution, preferably to obtain several thin layers, and may be again lightly brushed to provide a smooth coated covered core as indicated by the reference numeral **18**. The coated textile wound core is now air dried; a second spiral winding **19** of a plastic thread, preferably nylon monofilament, is wound over the smoothed coating **18**, and is coated in the integrating solution, and lightly brushed to smooth the surface as indicated at **20**. The assembly is now stretched under tension and under predetermined heat conditions, to reduce the diameter and form a completely integrated string with increased tensile strength, as the three coatings soften under heat and pressure to lock the parts together. The stretched string, indicated by the reference numeral **21**, is now quickly cooled, either by air or by passing through a water bath, and the resulting product is a strong, completely integrated string having a highly resilient linear core with a composite armor sheath. The number and extent of the coatings are regulated to obtain a surface which will have a desired effective bite on a tennis ball when in play, and the preferred winding is of a close nature with the filament coils touching each other. When the string is manufactured for musical instruments, the number and extent of the coatings are regulated to provide a desired tone.

Although I have found that synthetic resin solutions may be used for integrating the string, a satisfactory coating solution includes nylon, dissolved with isopropanol and tetrahydrofurfuryl alcohol in a water base, the proportion of nylon being variable between the limits of 10 to 25% by weight, of isopropanol between the limits of 50 to 70% by weight, and of tetrahydrofurfuryl alcohol between the limits of 5 to 20% by weight, the proportions being chosen and sufficient water being added to provide a coating solution of suitable consistency.

Two specific formulae that have been found suitable for the desired coatings are as follows, based on a sixty pound batch:

Formula No. 1

	By weight, percent
Nylon	15
Isopropanol	65
Water	10
Tetrahydrofurfuryl alcohol	10

Formula No. 2

	By weight, percent
Nylon	20
Isopropanol	60
Water	10
Tetrahydrofurfuryl alcohol	10

The nylon, which is preferably of shredded type, is added to the other ingredients under heat to form the coating solution, and the proportions of the ingredients are varied to provide a desired stiffness in the final product. For strings requiring more flexibility, it is desirable to add a predetermined amount of plasticizer. It has been found that a string which has a diameter of .056 inch before integration will break under a dead load of one hundred pounds; after integration, with a diameter reduced to

.050 inch, the break load has risen to one hundred ten pounds.

The integration drawing for a string of the size described is preferably under a strain load of fifty pounds, using a drawing speed of about eight hundred yards per hour and a temperature of substantially 360° F. The resulting string has the stiffness suitable for use in tennis racquets and the like. Change in drawing speed, pull and temperature will produce a variation in the stiffness; the range of speed is from two hundred to one thousand yards per hour, and the range of temperature is from 250° to 400° F.

A string made as described has high tensile strength, very high resiliency when strung, and great resistance to fatigue and distortion, whereby the racquet strings hold their shape, give long wear, are water repellent, and do not elongate or stretch with continued use. When the string is made of nylon, the linear core provides high resilience, and molecular orientation is produced by the stretching and is fixed by the quick cooling.

For certain string constructions the textile winding may be omitted to provide an all plastic string. The preferred material for the core is linear multi-filament nylon, which has high elasticity and resilience, the individual filaments being as small as .002 inch in diameter. The preferred material for the outer spiral layer is monofilament nylon of larger cross-section, such as .008 inch in diameter, which produces a hard, tough wearing surface, the spiral winding having substantially no effect on the resiliency of the multi-filament core although integrated with the core.

Other suitable plastic monofilament material of the polyamide, Vinylite and polyester type may be used for composite strings for different uses, with textile and silk cores of sheaths, and in combination with plastic materials, suitable binders being utilized to integrate the flexible material core with a cover or sheath of tough material.

Although I have described a specific string construction designed for racquets and musical instruments, it is obvious that the string may be used for other purposes, such as for example for fish-hook leaders, and fishing lines,

and that changes in the size and shape of the parts and in the material used may be made without departing from the spirit and the scope of the invention as defined in the appended claims.

I claim:

1. In the manufacture of strings, the steps of forming a core of linear multi-filament strands of thermoplastic material, coating the core with a solution of the same thermoplastic material, drying the coated core, winding a monofilament of the same thermoplastic material on the dried coated core to form a spiral layer thereon, coating the spiral layer with a solution of the same thermoplastic material, and drying the spiral layer coating, whereby a composite string results.

2. In the process of claim 1, said thermoplastic material being nylon.

3. In the process of claim 2, subjecting the composite string to stretching under tension and heat to integrate the core, the spiral layer, and the coatings.

4. An integrated string having a core of linear multi-filament strands of thermoplastic material, a coating of the same thermoplastic material over the core, a spiral layer of the same thermoplastic material monofilament on said coating, and a second coating of the same thermoplastic material over the spiral layer, the core and layer being locked together by the coatings.

5. In the article of claim 4, the thermoplastic material being nylon.

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